

United States Army



Dental Research Detachment

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Accessions Research Consortium
January 2004



Continuous Monitoring of Salivary Osmolarity to Determine Overall Hydration Level in Soldiers

28 January



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Why is measuring hydration level important?



- Optimal physical performance is maintained when fluid consumption = fluid loss
- 2-6% of BML impairs performance
(general discomfort, irritability, apathy, weariness, fatigue, headache, dizziness etc.)





Military Relevance

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Military Relevance

- Heat injuries continue to comprise a significant percentage of training injuries
 - between 1992 and 2001 1433 soldiers were admitted to
the hospital for treatment of heat injuries
 - between 1997 and 2001 5833 soldiers were treated in
clinics for heat injuries





Military Relevance

- Dehydration is a critical component of all levels of heat injury: heat cramps, heat exhaustion and heat stroke
- Overhydration may cause hyponatremia, a life threatening condition
 - in 1999 the US Army revised its fluid replacement guidelines to prevent hyponatremia





Military Relevance

- Younger, more inexperienced soldiers suffer an increased incidence of heat injuries and hyponatremia
 - an inordinate percentage of heat injuries and hyponatremia occurs during BCT
 - new soldiers need time to acclimate to the hot environments encountered at BCT stations





Military Relevance

- Giving military commanders and medics the ability to continuously monitor hydration status of Soldiers offers a tremendous preventive potential for both heat injury and hyponatremia
- This ability would represent a significant force multiplier





Potential Solution for Dehydration and Hyperhydration



- Prevent by early detection
- Use reliable, non-invasive, continuous method to detect early stages of dehydration.





Objective

The goal of this project is to determine if saliva osmolarity can be used as a hydration level marker.





Ways of determining Hydration



- Several measures have been used to determine hydration level
 - urine osmolarity
 - urine specific gravity
 - urine color
 - blood/serum osmolarity
 - blood borne protein/sodium/hemoglobin concentration
 - bioelectrical impedance analysis
 - pulse rate and blood pressure





Determining Hydration in Soldiers

- Current method in the US Army is to measure fluid intake and urine output to arrive at the difference
 - very inaccurate since it neglects water loss due to sweating and respiration
 - very difficult to accomplish under ideal situations, impossible under increased MOPP conditions





Osmolarity

- Osmolarity = Total concentration of solutes (including ions) in a solution
- Osmolarity can easily be measured by freezing point depression





Why osmolarity?

- Osmolarity of urine and blood have been shown to be accurate indicators of hydration.
- As a dental research organization we are investigating using salivary osmolarity as an indicator of overall hydration levels.
- Osmolarity is a colligative property and can be used independent of saliva flow rate





Literature

- During initial stages of dehydration blood osmolarity is more sensitive than urine measurements
- Urine osmolarity is sensitive during the initial stages of dehydration but has a delayed response compared to blood osmolarity.
- Urine osmolarity is better for moderate to high levels of dehydration.
- Recent articles indicate saliva osmolarity may mirror blood and urine.





Why Saliva?

- Pros
 - Easy to access intraorally
 - Non-invasive
 - Inexpensive
 - Does not require a trained technician to collect
 - Can be collected continuously





Why Saliva?

- Cons

- Many components of saliva are greatly effected by flow rate
- Eating and drinking effect salivary components
- Unclear as to whether saliva osmolarity correlates of blood and urine osmolarity
- Food debris easily fouls intraoral sensors





Study plan

A pilot study will be conducted to determine a correlation between the saliva osmolarity and hydration status. This will be established by correlating blood and urine data.





Method

- It is known that urine and blood osmolarities can be used as hydration marker
- Volunteers will exercise in a hot and humid condition and give samples of urine, blood and saliva
- Blood and urine samples' data will be correlated with the saliva samples





Volunteers exercising



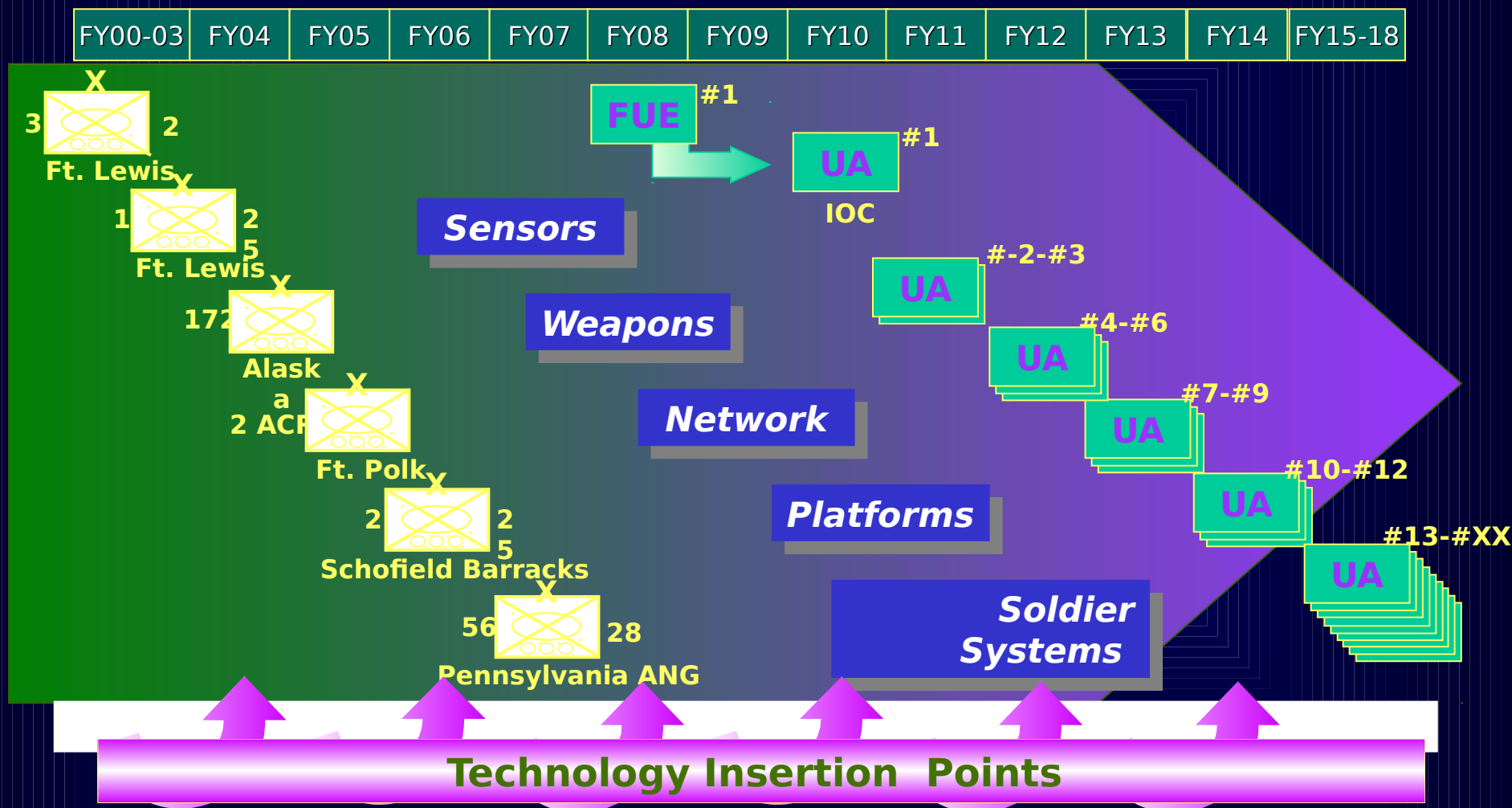
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Building an Army – Over Time



Balancing the Right Mix of Legacy and Interim Forces with Fielding the Objective Force



Parallel SBIR study

Bay Materials, LLC. is developing a miniaturized microfluidic salivary analyzer that when placed intraorally, provides rapid monitoring and transmission of the levels of salivary osmolarity in soldiers.





Picture of sensor



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Advantages of Intraoral Sensors

- Easy placement
- Easy recovery
- Well protected
- Difficult for enemies to detect/defeat
- Soldier can be aware if displaced





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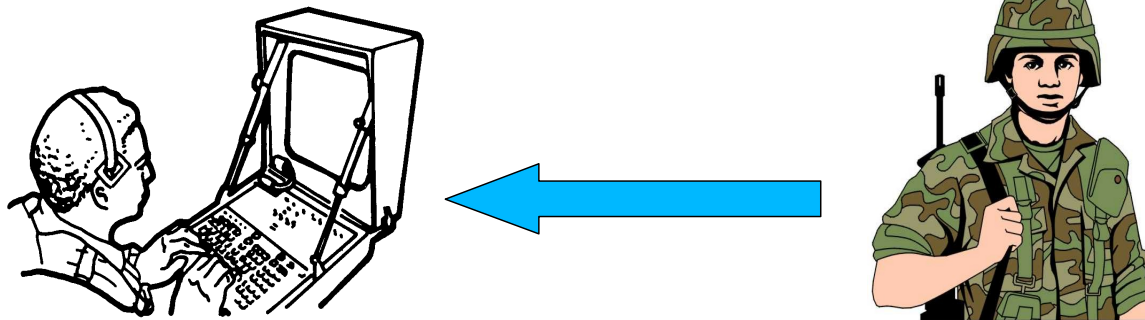


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BayMaterials

Dehydration Sensor for Soldiers



PROPRIETARY INFORMATION

April, 2003

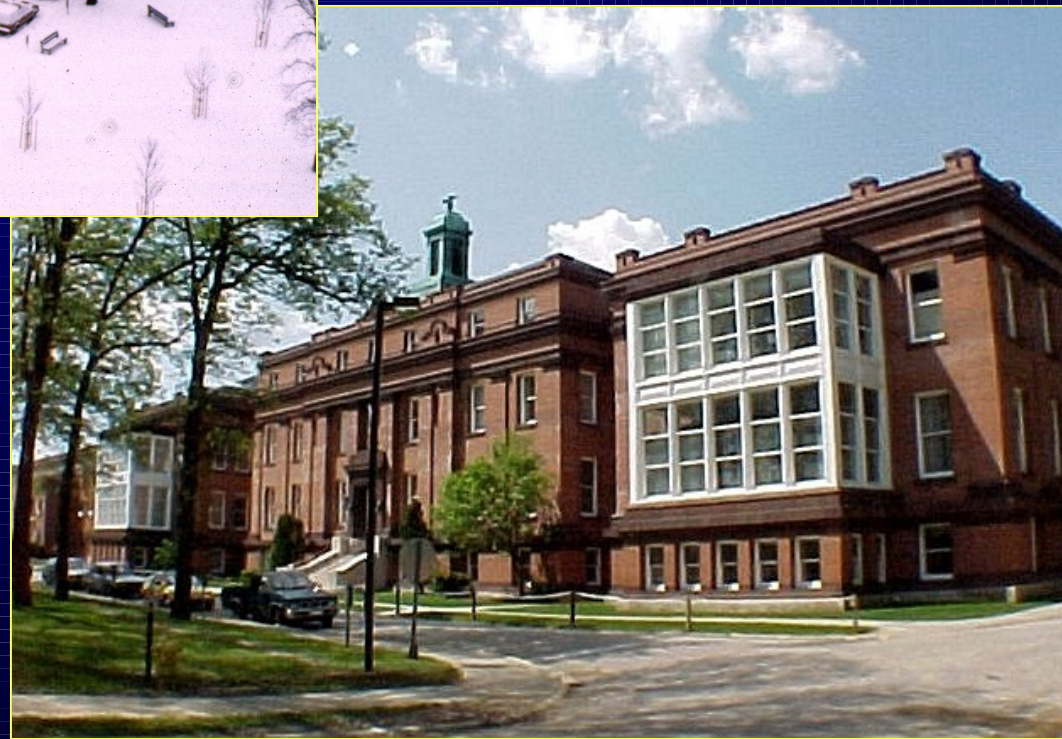
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Questions?



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